

Cypraea spadicea Gray.	Arca grandis B. & S.
Ranella californica.	Dosinia ponderosa.
Pomaulax undosus Wood.	Pecten subnodosus.
Conus californicus Conr.	Fusus dupetithouarsi Kiener.
Semele decisa Conr.	Drillia penicillata Cpr.
Uvanilla regina Stearns.	Monoceros muricatum Brod.
Venus fordii Yates.	Crucibulum imbricatum.
Triton gibbosum.	Purpura biserialis Blve.
Macron aethiops.	Venus undatella Sby.
Cymatium corrugatum Lam.	Cassis sp.
Conus gradatus Mawe.	Oniscia sp.

For several miles along the cliffs on the southwest coast of Cedros extends a well marked stratum about a foot in thickness of *Lucina californica*, and very strangely not another marine species was found with them.

In about ten fathoms off Palm Spring on the east coast we succeeded in making one haul of the dredge with the following results: *Hemicardium biangulatum*. *Nassa insculpta*.
Pecten latiauritus.

A number of small or difficult species collected on the trip remain to be identified. A list of them will appear later. Dr. Pilsbry has in press an illustrated paper on the Helices of the *Micrarionta* group collected.

As the weather was unfavorable for a continued southerly cruise, we reluctantly headed the "Flyer" for home where we arrived just four weeks from the time of starting.

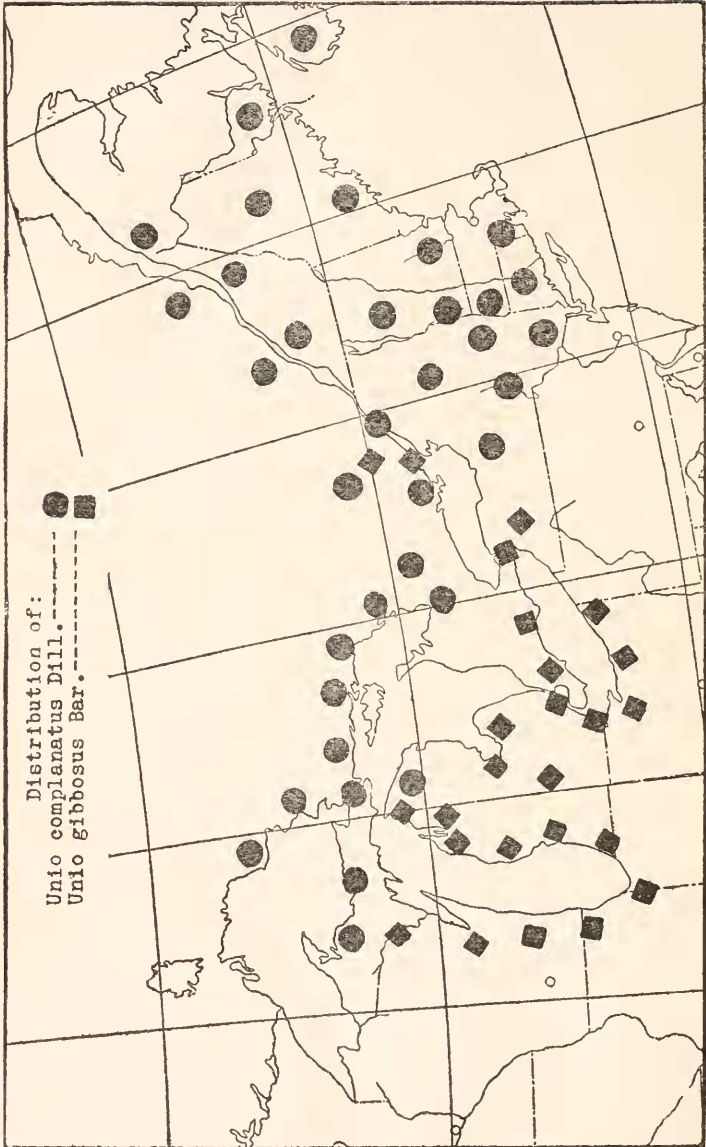
THE UNIONE FAUNA OF THE GREAT LAKES.

BY BRYANT WALKER, SC. D.

(Continued from page 23.)

The distribution of these two species, *Unio complanatus* and *U. gibbosus* (fig. 2), in a general way, shows the relative position the Atlantic and Mississippian faunas occupy in the region of the Great Lakes. Of course there are variations in the range of individual species, but these, on the whole, do not interfere with the general proposition to be discussed in this paper.

FIG. 2.



The discussion, then, includes the consideration of four questions: 1st, the origin of the Atlantic and Mississippian faunas; 2d, how and when the peculiar extension of the Atlantic fauna to the northwest took place; 3d, how and when the extension of the Mississippian fauna into the Great Lakes took place; and 4th, whether the peculiarly modified fauna of Lake Erie, as it exists to-day, is the result of a pre-glacial invasion, which survived in that region during the glacial period, or whether it was a post-glacial immigration.

I.

In considering the present distribution of the Naiad fauna of North America it is to be borne in mind that while our knowledge as yet is only fragmentary, and there is a great deal more to be learned before definite final conclusions can be drawn, nevertheless there are certain fundamental facts which seem to be reasonably well established, and with which such tentative deductions as we may attempt to make at the present time must be in agreement.

In the first place, it seems to be well established that the peculiar North American Naiad fauna originated west of the Mississippi, in the region extending from Utah and Colorado north to Athabasca and Saskatchewan, in British America.

The earliest forms of recognizable Naiades that are known are from the Triassic and a few more are known from the Jurassic. All these forms are simple and comparatively uniform in their character. But towards the end of the Cretaceous Period, there was, for some reason or other, an extraordinary epidemic, as it were, of mutation in this group, and, in the rocks that were laid down in these western lands at that time, are to be found prototypes of many of the modern groups, which are to-day characteristic of the recent fauna.

In the second place, it is to be kept in mind that north of the line of glaciation, the entire system of drainage was radically changed as one of the results of the Glacial Period.

Thirdly, assuming the general proposition that the center of distribution of a group must be considered the region of the greatest abundance of individuals and the greatest diversity of specific development, it would seem to be reasonably well established that the present fauna of the Mississippian region has spread out from two great centers; the one on the east, in the head waters of what we

now know as the Tennessee System, and the other in the southwest, probably in the Ozark region.

Assuming the origin of the Naiad fauna in the western region above mentioned, the first question to be determined is the derivation of the Atlantic fauna from this primitive fauna of Cretaceous time in the west.

The oldest land in eastern North America is that known as the Laurentian Highlands of Eastern Canada. With the gradual elevation of the continent in early times, which ultimately resulted in a connected land surface from the east to the mountainous regions of the west, the earliest system of drainage that was established in the region now occupied by the Great Lakes, was, according to the consensus of the best geologic opinion, towards the west, and when, in process of time, the highlands known as the Appalachian Mountains and the Cumberland Plateau were raised up, they formed a water shed, which determined the then existing systems of drainage.

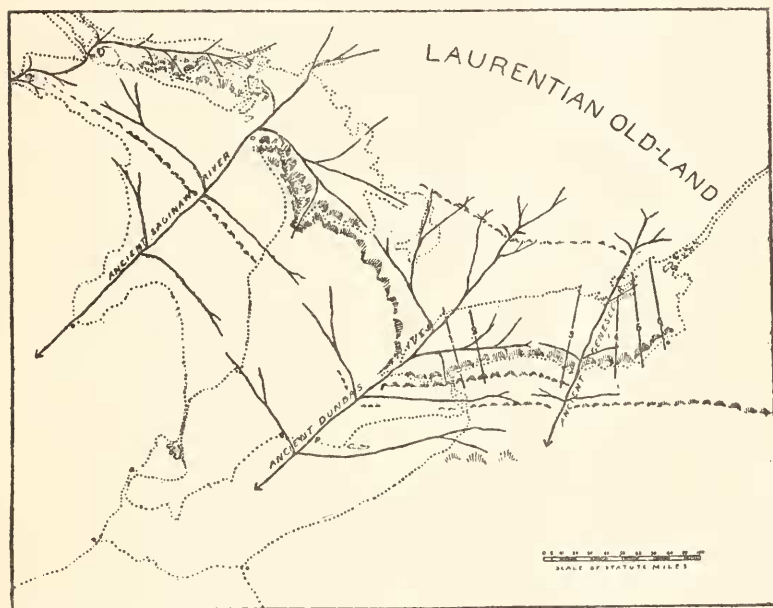
According to Branner (1), prior to Cretaceous times, the then Cumberland Plateau extended continuously from the Appalachian Mountains southwest into western Texas. At that time the Mississippi River was not in existence, the drainage from the south of this great water shed was into the Gulf of Mexico, the drainage from its north side was north and west, and probably in the beginning, ended in the great Mesozoic sea, which extended along the foot of the Rocky Mountains from the Gulf of Mexico to the Arctic Ocean.

While we do not know as much of the exact course of these pre-glacial rivers as we should like, nor as much as we hope to know in future, there has been of recent years a considerable advance in our knowledge in this particular, and there is enough of data now available to give us at least a general idea of some of the particulars of that ancient drainage system. It was, of course, entirely overwhelmed and nearly obliterated by the effect of the ice cap, which overthrew the ancient system, and from which grew our present system of drainage, but here and there there are enough remnants to afford us some information as to the lines along which this pre-glacial drainage system was established.

As shown by Fig. 3, which is copied from Grabau (2), the pre-glacial drainage of the region of the lower Great Lakes was towards the southwest. The ancient Dundas River, originating in the Laurentian Highlands, flowed southwesterly across the present bed of

Lake Erie, and possibly along the general course of the present Maumee and Wabash Rivers towards the western sea. In a similar way the ancient Saginaw River was a western-flowing stream, extending from the highlands on the east across the Georgian Bay, up the Saginaw Valley, and southwest towards the sea. And further north a similar drainage was also established. According to Fowke (3) the present course of the Ohio River is quite different from that of the great river which drained that region in pre-glacial

FIG. 3.



times. The present course of the Ohio is made up of fragments of ancient drainage beds united by connecting links forced through by the glacial waters on the retreat of the ice. According to Grabau the present bed of the Ohio is about 150 feet above the ancient bed of the pre-glacial drainage, and according to Fowke the Great Kanawha River, which is now a southern tributary of the Ohio, at that time flowed northwesterly across southern Ohio into Indiana, and presumably, either as a separate river or as a tributary of the Dundas, flowed westerly towards the sea or into the Mississippi.

If these theories of the ancient pre-glacial drainage of this region are correct, it does not require much imagination to see how, from their ancient place of origin in the west, the primitive ancestral forms of our present fauna were enabled to spread to the east up these ancient waterways to the headwaters of these pre-glacial streams, and then, during the many elevations and sinkings of Tertiary times, through the stream transference consequent upon such orographic changes, this immigration of the primitive fauna was transferred into the eastern drainage, and thus became the ancestral stock of the present Atlantic fauna.

That this emigration from the west to the east was a very early one, there can be no doubt, and that it was long antecedent to the Glacial Period seems beyond question, both from a geological and a zoological standpoint. The fact that not only from the Glacial Period, but for long ages prior to that time, the Appalachian system must have been a barrier to the entrance of the western fauna into eastern waters would seem to be beyond question, and this view is strengthened and corroborated by the fact that the two faunas have been so long separated that they have become specifically differentiated in the great majority of cases. The time that is involved in such a change must be very great. That it must be so is shown by the fact that the fossil *Unios* found in the inter-glacial drift of eastern Canada are the same as the recent examples of the same species found to-day. It is probable that this emigration from the west took place after the primitive fauna of early times had begun to mutate under the peculiar influence of the later Cretacic times, and while, of course, there is much that is indefinite and purely speculative in regard to these questions, there are some facts, which seem to point with some directness, as to when that migration might have taken place.

One of the characteristic species of the Atlantic fauna is *Lampsilis radiata*, which extends at the present time along nearly the whole extent of the Atlantic drainage. It is very closely related to another characteristic species of the Mississippian fauna, the *Lampsilis luteola*, and, indeed, these two specimens are so closely related that while in the main there is no difficulty for the average student to separate them, yet oftentimes there are individual specimens which are very difficult to place with entire satisfaction.

(*To be continued.*)